Salton Sea Management Program
Habitat Design Criteria
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Summary and Purpose

This document describes the Salton Sea Management Program (SSMP) Habitat Design Criteria. The Habitat Design Criteria are intended to guide SSMP project-specific habitat objectives to achieve the Habitat Goals for aquatic habitat identified in the SSMP Work Plan. The Habitat Design Criteria were developed considering fish and wildlife ecology, water quality and project site limitations, and risks that cannot be fully addressed through design criteria. Scientific knowledge of the ecology of the Salton Sea ecosystem, information in various environmental documents, technical reports, studies, permits, and plans were consulted during the development of this document. Additionally, in future years after projects are constructed and operating, monitoring and adaptive management data and results of subsequent scientific investigations will inform revisions to the Habitat Design Criteria.

Habitat Overview

The SSMP Phase I: 10-Year Plan will design and construct habitat projects on areas of exposed playa at the Salton Sea. A goal of the SSMP is to develop projects to protect or improve wildlife habitat to minimize ecosystem impact at the Salton Sea in the mid-term. Construction of new habitat will be constrained by the available water sources: the Salton Sea, rivers, and agricultural drains. Used directly or blended, the current range of water salinity available for use in constructed habitat is three to 60 parts per thousand (ppt). Higher salinities could be achieved as the lake becomes more saline within the 10-year period of the SSMP Phase I or by evapo-concentration within constructed habitat. The approach to habitat construction is also guided by a need to maximize coverage of the exposed playa, which will result in open water habitat much more shallow than the existing lake's depth of close to 50 feet.

Designing within these constraints, implementation of the SSMP, Phase I: 10-Year Plan, will provide habitat for a wide variety of fish and wildlife resources. Species such as desert pupfish (*Cyprinodon macularius*), tilapia (*Oreochromis mossambicus x O. urolepis hornorum and O. aureus*), sailfin molly (*Poecilia latipinna*), and western mosquitofish (*Gambusia affinis*) are expected to comprise the fish communities in created and enhanced aquatic areas. The fish, in conjunction with diverse invertebrate and phytoplankton communities, and a few plant species, will provide the main biotic components of bird habitat. Combined with structural habitat components, the biota will provide diverse habitat usage opportunities for bird and species of the Salton Sea ecosystem.

Habitat Goals and Relationship to SSMP

Design, construction, and management of habitat will create a mosaic of conditions to support several fish and wildlife goals. These goals are:

- Provide heterogeneity of conditions such as salinity, flow, water depth, bathymetry, substrate, and submerged vegetation to foster complexity of fish and invertebrate communities to provide diverse foraging opportunities for birds
- Create habitat that supports fish, such as tilapia, to provide a food source for piscivorous birds
- Create habitat that supports desert pupfish
- Create structural elements for varied bird use, such as islands, berms, and snags for colony bird nesting and loafing

Habitat types in and around the Salton Sea utilized by numerous avian and fish communities include playa, mudflats and shallow saline water, mid-depth saline water, deep saline water, permanent vegetated wetlands, agricultural lands, direct drains, and halophytic scrub (Case et. al. 2013)(Jones et. al. 2016). As the Salton Sea shoreline continues to recede, some unique habitat types will be lost or greatly diminished in value including river deltas, deep water, and barnacle beaches. While the SSMP will not recreate these unique resources, the Habitat Goals provide a range of constructed habitats and ecological conditions. Habitat constructed for the SSMP potentially includes mudflats and shallow saline water, mid-depth saline water, deep saline water, and permanent vegetated wetlands.

Habitat Goals will be influenced by a number of water quality factors, including salinity, temperature, dissolved oxygen, nutrients, and selenium, and how these factors are integrated and managed. Successful design and implementation of projects that achieve these goals will provide habitat for many of the fish and wildlife species of the Salton Sea ecosystem.

Habitat Design Criteria and SSMP Project Design and Implementation

The Habitat Design Criteria are broad criteria addressing physical habitat design of SSMP projects for fish, wildlife and aquatic biota to meet the Habitat Goals described in the SSMP Work Plan. SSMP project-specific design documents will incorporate one or more Habitat Design Criteria during development of prescriptive design criteria for habitat to achieve one of more Habitat Goals. All Habitat Design Criteria may not apply to every SSMP project and every Habitat Goal may not be achieved by every SSMP project. Risk evaluation, monitoring, and adaptive management actions are described as part of the Habitat Design Criteria. Project-specific documents will evaluate actions to manage risks and unknowns. A Monitoring and Adaptive Management Plan developed for the SSMP will include monitoring protocols, success criteria and adaptive management strategies to evaluate and adjust Habitat Design Criteria.

Water Quality

As a water body with no outlet, the Salton Sea has become impaired by the accumulation of dissolved and suspended inputs from the agricultural drains and the rivers that collect these drain waters. The water quality components with the largest negative impacts to fish and wildlife are salts, selenium, and agricultural fertilizers. Additional parameters which compromise the vigor of fish and wildlife populations are turbidity and low oxygen levels.

The water entering the Salton Sea is not saline, but only moderately brackish. Newly created habitat will rely on water sources from the remaining hyper-saline Salton Sea, brackish drain waters, and river water. The present day range of salinity allowed by these sources alone, or blended, is from 3-60 ppt salinity. All options for the input water for created habitat currently fall within that range. However, within the ten-year scope of the Work Plan, the Salton Sea could provide higher salinity water.

Maintaining the salinity of water in SSMP habitat above 20 ppt would have several implications for risk management: 1) reduce the number of mosquito species that can invade habitats, 2) limit encroachment of invasive tamarisk, 3) prevent accumulation of decomposing emergent aquatic vegetation, thus reducing the risk of selenium uptake into the food chain, and 4) exclude invasive and undesirable freshwater biota from constructed habitat.

Selenium occurs naturally in the soils of the Colorado River watershed. It accumulates slightly as the river carries water to the Imperial and Coachella valleys. It accumulates further as the waters soak and drain through the agricultural lands surrounding the Salton Sea. After over a century of drain water inputs to the Salton Sea, dissolved and suspended selenium has accumulated. Sediment at the bottom of the lake, under an almost constantly maintained anoxic hypolimnium, has acted as a sink for selenium. Comparative studies have shown that selenium levels in fish and birds has not increased substantially at the Salton Sea over the last several decades. Selenium in the eggs of many bird species sampled around the lake has been near or above the projected risk level for impairment of embryonic development.

The runoff of fertilizers from Imperial and Coachella valley agricultural lands is a consequence of standard flood irrigation practices. Unlike selenium, the nutrients from fertilizer runoff are not sequestered in an inert condition at the bottom of the lake. The fertilizer-derived nutrients are utilized by aquatic microbial communities, particularly by algae, and support high primary productivity. The high productivity has supported many fish and invertebrates, which have supported many birds. Nutrients and the organic components of dead organisms can accumulate and undergo anoxic decomposition. When the products of that decomposition (particularly hydrogen sulfide) are brought up through the water column, oxygen may become limiting, resulting in deaths of fish and aquatic invertebrates. The limiting chemical element in the creation of the primary productivity organisms is phosphorus. Reducing phosphorus levels would have the effect of reducing frequency and duration of anoxic events. Water in the SSMP created habitat will likely be eutrophic (nutrient rich), but the risk for toxic upwelling will be dependent upon the water depth and wind patterns.

Water quality is a large constraint to designing functional habitat. Individually or blended, the water sources for SSMP projects present a suite of water quality constituents that will create challenges for constructing fish habitat, namely high nutrient levels, low oxygen levels, and very warm temperatures. In addition, driven by the native topography, and the need to cover as much exposed playa as possible, waters in created habitat will be shallow, relative to the Salton Sea. How these factors are integrated into a project design will establish which communities of fish may be supported.

Fish

Fish species in SSMP constructed habitat will provide foraging opportunities for fish-eating birds. A community of fishes persisted in the Salton Sea and its connected agricultural drains for decades during which the salinity of the sea ranged from 20 to 40 ppt. From this community, tilapia, sailfin mollies, mosquitofish and desert pupfish are expected to comprise the community supported by SSMP project habitat. These fishes have characteristics including tolerance of relatively saline water, flexible foraging requirements, the ability to survive in very warm, poorly oxygenated water, and suitability as prey for several feeding guilds of birds, which are appropriate for the constructed habitat. The proposed fish community species have adaptations that will reduce the water quality challenges to some degree. Nevertheless, habitat design needs to accommodate the following factors, to the degree feasible.

Fish will need salinity to stay within a range from brackish to saline, i.e., 3 to 40ppt salinity. At the high end of this range (30-40ppt) all fish species will persist, but some may face physiological challenges that can impair reproduction and survival. When high salinity is combined with temperature and oxygen stressors mortality may occur. Above 20ppt salinity, invasion into SSMP habitat and establishment by non-desirable freshwater fish will not be possible.

There is no predetermined absolute depth that is necessary to support the fish community. However, thermal stratification and thermal inertia are largely a function of water depth. Deeper water will help to combat temperature extremes. Relatively deeper water will be slower to equilibrate with extreme ambient air temperatures. All proposed species function well in the higher water temperatures of the Salton Sea, but tilapia face severe thermal challenges during periods of cold temperatures. Water temperatures around 50° F can be lethal to tilapia in saline waters. Tilapia have traditionally occupied Salton Sea waters up to 30 feet deep. Breeding has been observed to occur in waters of five feet and less.

A mix of water depths will help create the microhabitats that will support the several feeding niches preferred by the species of the fish community. A varied bathymetry will provide areas of variability in turbidity, temperature, dissolved oxygen, light penetration, submerged plant distribution, nest site selection, and predator avoidance opportunities. Some of this heterogeneity will be provided by the creation of borrow pits for island and berm construction and by topography and berm height. Inclusion of deeper channels in the habitat will have the added benefit of allowing refugia for fish in the event of a breach in a containment berm or when the water level is temporarily lowered as an emergency action or adaptive management response.

Much of the native substrate in the footprint of the SSMP is fine grained and non-compacted. As it has been in the Salton Sea, this substrate type will provide productive communities of macroinvertebrates, which will vary with depth, salinity and season. Any rugosity provided by the substrate captured in the footprint of created habitat will have the additional benefit of attachment for benthic algae and barnacles, along with the commensal invertebrates that benefit from the structure. Aquatic invertebrates will also benefit from points of attachment provided by riprap, concrete, or other hard structure incorporated into habitat design.

Available water sources for SSMP habitat contain relatively high nutrient levels. Some nutrient reduction may take place in the sedimentation and/or mixing basins as nutrients associated with suspended particles fall out of the water column due to lowered velocities. The potential for algae blooms, which lower dissolved oxygen levels, remain a concern for habitat management. Chemical stratification, particularly the accumulation of hydrogen sulfide in an anoxic hypolimnion, will not become established long term, in waters more shallow than ten feet deep. The normal pattern of winds will facilitate the frequent mixing of strata in the created habitat.

Some structural elements of constructed habitats (e.g., sedimentation basins, water transport canals) may contain waters of relatively low salinity, and support a more diverse community of fishes. These species may include desert pupfish, common and grass carp, sailfin mollies, bluegill, largemouth bass, tilapia, mosquitofish, threadfin shad, red shiners, catfish and other species inhabiting the drains and rivers that flow into the Salton Sea. Communities will form opportunistically from the fish already present in the drain and river waters.

Desert Pupfish (*Cyprinodon macularius*)

The desert pupfish, is endangered throughout its range primarily due to habitat destruction or alteration, and the introduction of non-native species. (USFWS 1993). This species is the only native fish in the Salton Sink. The Desert Pupfish Recovery Plan (USFWS 1993) describes seven tasks that are required for the recovery of the species. Among these are the protection of natural populations and habitats, and the re-establishment of 36 populations in the most natural habitats remaining within the probable historic range. Significant, immediate and specific threats to desert pupfish throughout the Salton Sink currently include habitat desiccation or degradation resulting from water management or stochastic events (e.g. earthquakes), encroachment of invasive vegetation, and interactions with non-native fishes and other fauna. Non-SMMP projects are planned to construct desert pupfish habitat in the northeast area of the Sea, sites near San Felipe Creek, Salt Creek, the wash near Bombay Beach, and some of the irrigation drains. However, given the difficulties of obtaining a reliable water source, it may not be feasible in some areas, and created habitat may be restricted to areas near the Whitewater, New and Alamo rivers or some of the irrigation drains.

Historical habitat for desert pupfish varied in complexity, size, and permanence, and included cienegas, springs, streams, and margins of large rivers and lakes (USFWS 1993). In California, natural populations of desert pupfish currently inhabit the Salton Sea, San Felipe Creek, Salt Creek, an unnamed wash south of Bombay Beach, irrigation drains, and shoreline pools or ponds. Desert pupfish are omnivorous and opportunistic, foraging for items such as detritus, algae, parts of macrophytes, aquatic insects and larvae, snails, pile worms, and small aquatic crustaceans. Desert pupfish are highly tolerant of extreme environmental conditions, including anoxic and hypersaline waters. While desert pupfish may tolerate dissolved oxygen as low as 0.1 to 0.4 mg/l (Lowe et al. 1967), cumulative effects of various stressors may result in mortalities. Salinity tolerance ranges from freshwater to 68-70 ppt for adults and eggs (Barlow 1958, Schoenherr 1988), and up to 90 ppt for larvae (Barlow 1958, Schoenherr 1986). Preferred water temperature for juveniles is 30°C at 35 ppt while for adults the preferred range is 22-26° C at 15 ppt (Kinne 1960). In thermal tolerance studies, desert pupfish have tolerated temperatures as low as 4.4°C (Schoenherr 1990) and as high as 42.4 to 42.7° C (Schoenherr 1990, Carveth et al. 2006). In the lab, optimum water temperatures for spawning were determined to be 28-32° C (Kinne 1960).

Besser et al. (2012) found that desert pupfish growth and survival were not affected during selenium-enriched feeding trials, although there was some impairment to reproductive output. Egg production of desert pupfish was reduced when exposed to selenium concentrations of 4.4 micrograms per gram dry weight of food. Evaluation of selenium risk to desert pupfish on a project by project basis is warranted, but is not expected to be a limiting factor.

Substrate requirements for desert pupfish are driven by their foraging, breeding and other behaviors, and preferably consist of non-compacted material such as sand-silt. Desert pupfish engage in a behavior called pit digging, which is the excavation of substrate while foraging. They may escape extreme temperatures or other stressors by burrowing into the mud (Legner et al. 1975, Schoenherr 1988). Additionally, there have been anecdotal reports of eggs hatching from the muds of dried experimental ponds after a week (Deacon and Minckley 1974). Preferred egg deposition sites are 18-22 cm deep (Courtois and Hino 1979) within territories that are topographically diverse (Kodrick-Brown 1977).

Structure is an important component of these territories as breeding activity often centers on a submerged object. Eggs are occasionally laid on the underside of floating algae mats or bottom debris (Legner et al. 1975). Desert pupfish typically spawn from late March through September (Matsui 1981) or early October, and may lay as many as 800 eggs during a season (Crear and Haydock 1971). Desert pupfish populations may increase rapidly in preferred habitat, and subsequently these fish may emigrate to other habitat as a means of regulating their populations (McMahon and Tash 1988). Connectivity to other habitats is required for long-term persistence of desert pupfish populations by providing the ability for natural expansion and gene flow.

Birds

The Salton Sea, designated an Audubon Important Bird Area of global significance, is an important inland habitat for birds along the Pacific Flyway. The diverse habitat is utilized by birds from both the Pacific and Central Flyway and their use of the lake changes throughout the year; for example, individuals of a single species, such as Clark's Grebe, may occur at the sea as over-wintering birds, spring or fall migrants and as local breeders (Cooper 2015).

Considered a branch of the Lower Colorado River Delta, the Salton Sea formed and dried multiple times prior to its most recent iteration. After the flooding of the sea by water from the Colorado River, migratory birds began to use the sea, and a number of species became residents there. Due to loss of aquatic habitats elsewhere in the west, the Salton Sea ranges from important to essential for some bird species. Varied habitat of the sea has provided forage in the form of fish, and invertebrates along the shoreline, exposed mudflats, and at the water's surface. Islands and snags that are surrounded by water have provided protection from predators during resting, roosting, and nesting. The sea is the primary wintering area in the interior U.S. for the American White Pelican, and Western Snowy Plover. Gull-billed Terns, have bred locally on islands at the south end of the sea. The *rostratus* race of the Savannah Sparrow, is a true Delta endemic which breeds in desert wetlands at the head of the Gulf of California, and disperses north to the sea in fall (Jones et. al. 2016).

The Salton Sea is a historic breeding location for colonial nesting birds. Several waders, including Great Blue Heron, have their largest nesting colonies in the state at the Salton Sea, where they utilize dead trees both on the sea and in flooded impoundments along its edges. On the sea's few islands, up to 25% of the breeding Caspian Terns in North America may breed in some years, where they are joined by Double-crested Cormorants comprising some of the largest western U.S. breeding populations. It is this group – the breeding "inland seabirds" that might be among the most threatened as the sea shrinks. Over the past several years, their nesting islands have become connected with the shoreline, allowing predators to access to the cormorant and tern colonies. Due to fewer protected islands being available, there is increased competition by birds for space on protective islands, and access to roost locations.

The Federally Endangered Yuma Ridgway's Rail *(Rallus obsoletus yumanensis)* (formerly Yuma Clapper Rail) occurs in great numbers near the Salton Sea. Forty percent of the global population occurs in cattail marshes, and the irrigation canals and natural rivers that enter the sea. As the drains and streams are becoming further disconnected with the main body of the Salton Sea, brackish wetlands are forming at the mouths and creating potential rail habitat. The presence of rails, and the selenium risk from the water source(s) for the project, will determine if the creation of vegetated freshwater wetlands is appropriate. Since Yuma Ridgway's Rail requires habitat with emergent aquatic vegetation, it requires water with salinity less than 20 ppt. Higher salinity would exclude the growth of cattails and prevent useable rail habitat from forming. Selenium levels in vegetated freshwater habitat is more bioavailable than in non-vegetated wetlands, and poses a higher risk of reproductive impairment for rails.

The birds that utilize the Salton Sea mainly forage for fish and aquatic invertebrates within various habitat types. Factors that affect bird usage are the amount of shallow water, amount of open water, presence of suitable food including fish, sediment composition which influences available invertebrate communities, and proximity to rivers and river mouths for access to freshwater (Jones et. al. 2016). Birds can be separated into feeding guilds, which are based upon the United States Forest Service research which grouped species that use similar resources in similar ways. The proposed classification used a three-part identification for each guild—major food, feeding substrate, and foraging technique. (DeGraaf et. al. 1985). Habitat types for the SSMP potentially include mudflats and shallow water, mid-depth water, deep water and permanent vegetated wetlands.

Multiple guilds of birds are expected to utilize habitat types described below:

<u>Mudflats and Shallow Water</u>
Ambushing omnivores (includes large wading birds), dabbling and diving ducks, gulls, terns, hawks and falcons, skimmers, ground foraging shorebirds (including sandpipers, yellowlegs, and plovers), and probing shorebirds (including Willet, Whimbrel, Sanderling, Dunlin, White-faced Ibis, Oystercatcher, and Stilt Sandpiper). Forage types: vermivore, piscivore, crustaceovore, insectivore, carnivore, herbivore, and granivore.

<u>Mid- Depth Habitat</u>
Ambushing omnivores (includes large wading birds), dabbling and diving ducks, gulls, terns, hawks and falcons, skimmers, ground foraging shorebirds (including sandpipers, yellowlegs, and plovers), and probing shorebirds (including Willet, Whimbrel, Sanderling, Dunlin, White-faced Ibis, Oystercatcher, and Stilt Sandpiper). Forage types: vermivore, piscivore, crustaceovore, insectivore, carnivore, herbivore, granivore.

<u>Deep Water Habitat</u>
Supports plunging and diving birds, that are mainly piscivorous, but also crustaceovores, such as Double Crested Cormorants, Brown Pelicans, and American White Pelicans. Also supported are pelagic scavengers such as gulls, skimmers, diving ducks, ambushing wading birds, and hawks and falcons. The habitat would support other groups of birds that may feed on the edges of the pond, and utilize the structures such as islands.

<u>Permanent Vegetated Wetlands</u>
Supports Yuma Ridgways Rail, ambushing wading birds, dabbing and diving ducks, skimmers, scavengers, ground foraging shorebirds (including sandpipers, yellowlegs, and plovers), and probing shorebirds (including Willet, Whimbrel, Sanderling, Dunlin, White-faced Ibis, Oystercatcher, and Stilt Sandpiper. Mainly omnivores, herbivores, insectivores, and crustaceovores. Additionally freshwater wetlands may provide a local source of freshwater for all of the bird guilds to utilize.

Habitat parameters will vary between habitat types and include water depth ranges, habitat size, sediment composition, salinity, structural elements, vegetation, and proximity to other resources (rivers and river mouths). Each habitat should provide suitable forage opportunities, minimize risk of selenium, and create islands and snags for nesting and loafing birds. Island characteristics include slope, substrate, erosion armoring, height above water line, orientation, vegetation, size, shape, and distance to shore. Reducing the of risk of predation on created islands by following best practices for island creation provides increased benefit to birds that use the islands.

Habitat type specific parameters are as follows:

Mudflats and Shallow Water

Water depth	< 15 cm (25% of landscape)
Sediment	Silt (10-45%), Sand (15-50%), Organic content (< 20%)
Bathymetry	Gradually sloped. Some with >90% mudflats
Salinity	0-100 ppt
Preferred proximity to Rivers/Freshwater	5 km
Preferred proximity to permanent shoreline	1 km
Anticipated Bird Guilds	shorebirds, ducks, gulls, terns, hawks, wading birds
Forage Species	Small fish, crustaceans, invertebrates, vegetation, worms

Mid-Depth Water

Water depth	mid-depth: 15-30 cm; on average < 1.5 m in surrounding open water
Habitat size	Few thousand m^2 to > 2 ha of mid-depth water; 5-20 ha of open water
Exposed shoreline	Few thousand m^2 to > 2 ha
Salinity	0-50 ppt
Preferred proximity to Rivers/Freshwater	6 km
Preferred proximity to permanent shoreline	300 m
Anticipated Bird Guilds	Shorebirds, ducks, gulls, terns, hawks, wading birds
Potential Structures	Nesting and loafing Islands
Forage Species	Fish, crustaceans, invertebrates, vegetation, worms

Deep Water

Water depth	> 30 cm; 1-4 m on average
Habitat size	few thousand m2 to > 25 ha; as much as possible open water
Sediment	Silt (10-40%), Sand (20-60%), Organic content (> 2%)
Salinity	0-50 ppt

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Preferred proximity to Rivers/Freshwater	5 km
Preferred proximity to permanent shoreline	1.5 km
Anticipated Bird Guilds	Pelicans, Cormorants, diving ducks, gulls
Potential Structures	Snags, nesting and loafing islands
Forage Species	Large fish, invertebrates, crustaceans

Permanent Vegetated Wetlands

Water depth	< 1 m on average
Habitat size	1 to > 10 ha
Exposed shoreline	> 10 ha
Vegetation	Few thousand m^2 to <10 ha of herbaceous vegetation
Salinity	0-20 ppt
Preferred proximity to Rivers/Freshwater	10 km
Anticipated Bird Guilds	Yuma Ridgway's Rail, ducks, wading birds, shorebirds
Potential Structures	Nesting and loafing islands
Selenium	The potential risk of selenium impacts should be closely evaluated
Forage Species	Vegetation, Invertebrates, crustaceans

Habitat Design Criteria

The Habitat Design Criteria were developed by synthesizing scientific information that is summarized in this document. Specifically, the Habitat Design Criteria are feasible at the proposed SSMP habitat project locations and available water sources, address fish and bird habitat needs, will guide project-specific habitat objectives, will advance the Habitat Goals, and consider ecological risks.

Some Habitat Design Criteria will be applied to all or most habitat projects, while others may only be applied based on project site conditions and Habitat Goals for each project. Some Habitat Design Criteria are more specific and numerical, while other criteria describe more general design characteristics, address factors that are still being refined, and others predominantly rely on native sediments and natural biological recruitment from adjacent habitats. As project-specific habitat objectives are developed during project design, such as for island creation and connectivity, more explicit Habitat Design Criteria will be developed.

Criteria:

Salinity - Range from 3- 40 ppt (20-40 ppt preferred)

Depth - Range of depths from inches up to 10 feet (mostly up to 6 feet in depth)

- Depths of 5 feet or less for fish breeding

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- Deeper areas to enhance thermal conditions for tilapia and larger fish
- Less than 10 feet deep to facilitate wind mixing
- Extensive, open shallow water less than 6 inch depth (2 -6 inches preferred)

Bathymetry – Variability, gradually sloped
- Provides for a range of habitat types and heterogeneity of conditions
- Deeper channels for fish refugia
- Some very shallow areas function as mudflats for bird use

Habitat (Pond) size – 0.75 acres to greater than 75 acres (Most ponds will be greater than 75 acres and provide for bird habitat types)

Flow (for desert pupfish) – Less than 1 cfs to minimize turbidity and allow for movement

Connectivity – Movement among habitats

Structure for Birds – Apply criteria to project-specific habitat objectives and inform more explicit criteria
- Create islands and snags for nesting and loafing birds
- Design appropriate slope, substrate, erosion armoring, height above water line, orientation, vegetation, size, shape, and distance to shore
- Specifics of island design will vary for each project based upon the habitat type, size, topography, and other site specific details
- Follow best practices for island creation to reduce the risk of predation on created bird structures

Sediment*
- Fine grained, non-compacted sediment, some with rugosity to enable invertebrate attachment
- Composition approximately: silt (10-45%), sand (15-60%), organic content (< 20%)
- Sediment depth 7-9 inches (for desert pupfish)

Vegetation* - For forage and cover
- Submerged or emergent; depending on salinity

** Projects are expected to utilize native sediment materials and rely on natural biological recruitment from adjacent habitat*

Uncertainty and Risk Management

Some potential negative impacts to the function of created habitat cannot be completely resolved by initial design choices. By design, the implementation and operation of early projects will provide feedback that contributes to understanding how successfully risks were minimized.

Primary among the risks not fully resolved are those from selenium. Selenium is ubiquitous in the sediments and waters of the Salton Sea ecosystem and the agricultural inflows. Risk from selenium can be modeled and anticipated, but not completely eliminated, using the waters and sediments available for SSMP habitat. Monitoring of selenium levels in SSMP habitat will be essential for feedback on the efficacy of avoidance and minimization measures. The most critical monitoring for risk assessment will be the evaluation of biological end points, namely the fish and birds that reproduce in the habitat.

Negative impacts from excessive nutrient levels within SSMP habitat will results from synergy with water residence time, water temperature, wind, air temperature, and water depths. Nutrient inputs can also vary over time within water sources supplying the habitat. These conditions can foster algae blooms and other biochemical phenomena that may drive the water to low oxygen levels. The constraints of available water sources and habitat depths may results in continuing vulnerability to episodic low oxygen events.

Predicted water temperatures in SSMP habitat may exceed the limits for fish survival. The negative effects of water temperature extremes can be partly ameliorated by water depth and total water mass, which increase thermal inertia. However, extreme water temperatures will primarily be driven by weather. The development the 640 acre SCH early project habitat design acknowledged some uncertainty about the ability of tilapia to persist through seasonal cold spells, as a proof of concept exercise.

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